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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

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**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

7399-2

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/720895INTERNATIONAL APPLICATION NO.
PCT/GB99/02141INTERNATIONAL FILING DATE
07/05/99PRIORITY DATE CLAIMED
07/03/98

TITLE OF INVENTION MODULAR BUILDINGS

APPLICANT(S) FOR DO/EO/US Peter William De La Marche

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:

☒ PCT Published Specification and Preliminary Examination Report

"Express Mail" label number EL496500562US Date of Deposit January 2, 2001
 I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR § 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.
Gail Mercer
 Signature of Person Mailing Correspondence

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17. <input type="checkbox"/> The following fees are submitted:				CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :					
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO				\$1000.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO				\$860.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO				\$710.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)				\$690.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)				\$100.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =				\$ 860.00	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	23 - 20 =	3	X \$18.00	\$ 54.00	
Independent claims	3 - 3 =	0	X \$80.00	\$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$270.00	\$ 270.00	
TOTAL OF ABOVE CALCULATIONS =				\$ 1184.00	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$ 592.00	
SUBTOTAL =				\$ 592.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$ 592.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
TOTAL FEES ENCLOSED =				\$ 592.00	
				Amount to be refunded:	\$
				charged:	\$

- a. ☒ A check in the amount of \$ 592.00 to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 23-3030. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

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REGISTRATION NUMBER

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MODULAR BUILDINGS

The present invention relates to modular buildings and more particularly to their structure, the method of their construction and interconnection.

It is well known to provide for portable modular building in circumstances where accommodation is needed in an emergency or on a temporary basis. Such buildings have to be rapidly and easily assembled to meet demand for emergency habitable structures in times, for example, of natural or other disasters. In addition such buildings are often required in remote locations by workers employed in the construction industry where temporary accommodation is needed during the term of the construction project.

There is a need for an all-purpose modular building system that can be exploited by both the residential and commercial construction sectors of industry. To date, portable and prefabricated buildings designs have not proved suitable for application in both sectors. Modular buildings have the advantages that they are easy and quick to erect, dismantle or relocate, are readily transportable, and flexible in that they are reconfigurable to meet changing requirements in size or needs. Unfortunately existing designs of such buildings are generally of a temporary nature and are not suited to long-term or permanent applications.

Existing modular buildings suffer from several disadvantages including: racking which causes wear and tear to the structure of the building and often leads to leaks, creaks and structural damage; condensation; inadequate interior temperature control; ineffective noise insulation; and an excessive ingress of dirt and dust (particularly in environments such as construction sites).

US-A-3742666 describes a modular building construction in which a pre-fabricated module for utility supply systems such modules can be delivered in a pre-fitted state to the construction site and assembled with limited effort and time. The module has side wall openings by which it may be attached to building modules.

It is an object of the present invention to obviate or mitigate the aforesaid disadvantages and to provide for a modular building construction that has improved life expectancy so that it meets the requirements of more permanent structures whilst

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maintaining the benefits of its modular nature. The term "building module" is used hereinafter to refer to an inhabitable building block that can be used as living quarters, an office, a conference room, a lavatory or washroom or another room that forms part of a larger building structure.

According to a first aspect of the present invention there is provided a modular building structure comprising a service module defining a plurality of connection nodes for connection to separate building modules, the service module containing apparatus for the supply and distribution of at least one mains service to the building modules, each building module being free-standing, pre-fitted for its intended use and connected to one of said connection nodes and to said supply of at least one mains service, wherein the service module is in the form of a corridor walkway linking the building modules.

The modular structure of the present invention provides for a very flexible arrangement in that once the service module has been installed on site the building modules can then be connected thereto in the desired number and fashion. If there is a demand for more building modules these can be simply added without the need to lay further mains service supplies. Similarly, removal of a particular building module is also a simple operation. As the mains service supply is contained within the service module the need for preliminary ground excavation is eliminated. Moreover little or no foundations are required.

The corridor may conveniently be provided with floor and ceiling cavities in which the mains service supplies are routed. Preferably one building module is a dedicated plant room that feeds the mains supply service to the service module.

The service module is preferably sectional so that it can be extended or shortened to provide more or less connection nodes as required. More than one service module may be provided and they may extend in transverse directions. The mains service may be electricity, waste disposal, air conditioning, water etc. In the case of waste disposal, each service module is provided with a holding tank and is connected to a lavatory or wash area of an adjacent building module. Preferably the holding tanks of adjacent sections of a service module are connected by a suction waste pipe.

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The arrangement eliminates the need for gravity operated waste disposal. In the case of air conditioning each service module is preferably fitted with a heat exchanger and has an external pump for evacuation of warm air. Each building module also has its own heat exchanger that is connected to the pump and heat exchanger of the adjacent service module.

Preferably each adjoining pair of building modules or service modules have apparatus for connecting adjacent modules, the apparatus comprising a housing defining apertures that extend into the structure of each module and a flexible resilient insert that is received in each aperture and bridges the two modules, the insert being supported on a fixing element that is secured to each of the modules.

According to a second aspect of the present invention there is provided a method for constructing a modular building structure, the method comprising the steps of: preparing a site on which the building structure is to be located; installing a service module on the prepared site, the service module defining a plurality of connection nodes for connection to separate building modules; installing at least one mains supply service to the service module; connecting at least one pre-constructed building module to a connection node and connecting the building module to the mains supply service of the service module; and furnishing the service module such that it is in the form of a corridor walkway linking the building modules.

According to a third aspect of the present invention there is provided an apparatus for connecting adjacent building modules, the apparatus comprising a housing defining an aperture that extends into the structure of at least one building module and a flexible resilient insert attached to adjacent module, the insert being that is received in the aperture and supported on a fixing element that is secured to said adjacent building module.

The housing preferably further comprises an access chamber that is open to the inside of the building module so as to facilitate insertion of the fixing element and flexible insert.

Preferably the apparatus for connecting adjacent building modules is disposed in a floor or ceiling cavity of the building module.

Specific embodiments of the present inventions will now be described, by way of example only, with reference to the accompanying drawings in which:

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Figure 1 is a perspective view of a modular building structure of the present invention constructed from a plurality of interconnected modules with certain panels removed for clarity;

Figure 2 is a sectioned side view of the intersection of two modules showing connecting points and a fixing assembly;

Figure 3 is a side view of a grommet of the fixing assembly shown in figure 2;

Figure 4 is a side view of a grommet housing of the connecting point shown in figure 2;

Figure 4a is a diagrammatic representation of a grommet for vertical connection of two building modules;

Figure 4b is a diagrammatic representation of a lifting hook;

Figure 5 is a perspective view of a corridor of the modular building, the corridor being shown partially cut-away and connected to a building module ;

Figure 6 is a perspective view of a two storey modular building in accordance with the present invention;

Figure 7 is an end view of a furnished corridor module with end walls removed for clarity;

Figure 8 is a schematic representation of an embodiment of a modular building of the present invention, showing a sewage system;

Figure 9 is a schematic representation of an embodiment of a modular building of the present invention showing an air conditioning system;

Figure 10 shows a diagrammatic layout of a modular office block building; and

Figure 11 shows a diagrammatic layout of a modular building forming a factory with offices.

Referring now to the drawings, figure 1 shows an exemplary modular building structure comprising a plurality of cabin modules 1 interconnected by corridors 2. The cabin modules 1 are designed to be furnished and used as, for example, offices or living quarters whereas the corridors 2 form passageways that, in addition to providing walkways between cabin modules 1, carry and distribute service supply

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lines to the cabin modules 1. The building shown has multiple storeys that are interconnected by a stairwell 3 in the foreground.

For the purposes of clarity end walls of the cabin modules 1 and all corridor walls are not shown. The only parts of the corridor shown are the floors and ceilings (which are combined on intermediate storeys).

The building structure is assembled from the cabin modules 1 and corridors 2 using the known honeycomb principle in which there is no overall super-structure and the integral strength of the structure is shared by each module both laterally and vertically so that should one module fail the load is taken up by adjacent modules. It will be seen from the drawing of figure 1 that the cabin modules 1 can be of different sizes although they are of the same basic construction. The cabin and corridor modules 1,2 can be designed in a range of standard sizes to allow for different building types and configurations to be assembled from factory produced units. The corridors 2 have the same basic construction as the cabin modules 1 but are adapted to have different end sections and different below floor or above ceiling structures. The modules 1 are interconnected in a fashion that makes them easy to replace or exchange so that the building can be updated or regenerated at any time.

The modular structure of the building is ideally suited to office buildings, hotels, schools, light industrial sites as well as residential buildings. It is not at this stage intended for buildings of a more significant size such as large factories, warehouses, stadiums and theatres etc.

The present invention is concerned with the structure and method of construction of the building structure and the manner in which the cabin modules 1 are fastened together.

Each cabin module 1 comprises a tetragonal box assembly having top, bottom and side walls 4,5,6 and open ends 7. The module 1 may be constructed in a range of different heights, lengths and widths. The tetragonal structure provides strength without end walls being necessary and without the need for expensive superstructures or foundations.

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Each cabin module 1 is fitted with an internal suspended ceiling and floor 8, 9 so as to define enclosed cavities 10, 11. The cavities 10, 11 accommodate service supplies, ventilation equipment, concealed lighting and other ancillary equipment.

Each cabin module 1 has a plurality of connection points 20 (see figure 2) disposed at regular intervals at the top and bottom of all four walls 4, 5, 6 and at open ends of the cabin. The connection points 20 permit adjacent cabin modules 1 to be connected together by fixing arrangements 21 (see figure 3) that are secured from inside the floor or ceiling cavities 10, 11 and are defined by housings 22 (one shown in figure 4) disposed in the floor and ceiling cavities 10, 11. Each housing 22 has a circular access chamber 23 that is open to the interior of the cabin and an elongate bore 24 extending radially from the access chamber 23 and out through a wall or an end frame of the cabin module 1. The fixing arrangement 21, shown in figure 3, comprises a double-headed fastening bolt 25 that carries a resilient but flexible grommet 26 of elastomeric material such as Neoprene or EPDM and two collars 27 each side of the grommet 26. In use the grommet 26 and bolt 25 extend into the aligned elongate bores 14 of the connection point housings 12 of adjacent cabin modules 1 so as to connect two cabin modules 1 together. Figure 2 shows the fixing arrangement 21 being used to connect together two cabin modules 1 side by side. The same arrangement is used to secure cabin modules 1 in vertical array, end-to-end or to connect corridor modules 2 to cabin modules 1. The open access chamber 23 of the housing 22 allows the fixing arrangement 21 to be easily inserted or removed.

The flexible and resilient nature of the grommet 26 permits adjacent cabin modules 1 to be coupled together without the requirement for their absolute alignment and without the fixing arrangement 21 becoming damaged or causing damage to the rest of the structure. This is essential for rapid construction of the building structure. Moreover, it allows easy reconfiguration, relocation or dismantling of the building structure. The fixing arrangement 21 provides primarily horizontal fixing strength but also partial vertical strength. The same connection point 20 and fixing arrangement 21 may be used to secure ancillary modules such as fire escapes, verandas stairwells etc. to the cabin or corridor modules.

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It will be understood that the provision of multiple connection points 20 on each module permits selective use of those points that are appropriately positioned for each connection.

When cabin modules 1 are stacked on top of each other they are secured in a vertical direction by means of a half grommet fixing arrangement 30 that is fixed to the upper surface of the cabin module 1 or a supporting frame member.

Each grommet 30 is moulded, at one end, around a protruding metal screw 30a that engages in a threaded aperture 30b in the cabin module or frame member. The other end has an axial opening which securely receives a bolt 30c. A collar such as one of those shown in Figure 3 may be disposed on the bolt 30c.

The modules are lifted and placed on top of one another so that each half grommet fixing arrangement 30 is received in an aperture in the bottom wall of the cabin module 1 or supporting frame member above. The half grommet fixings 30 are then secured in place to an appropriate fixing plate via the collar under the floor cavity 8 of the cabin module 1 above by means of the bolt 30c.

Figure 4b illustrates that the half grommet fixing 30 interchangeable with a lifting eye 31 that can be secured to lifting tackle when the cabin modules 1 are to be moved.

The cabin and corridor modules 1, 2 of the building structure may be supported and secured against the elements by one of many different foundation structures, none of which is depicted here. The integral strength of the tetragonal structure renders it versatile of use with different foundation systems. For example, for medium and long term applications metal rings attached to jacking legs of the module may be placed in the ground and filled with concrete. Alternatively for soft or snow covered ground skids may be secured to the module with half grommet fixings. For swamp land, inland water and areas prone to flooding floatation rafts such as polystyrene blocks encapsulated in concrete surrounds are secured to the module with half grommet fixings. In environments where high wind pressure may be a problem the modules may be fitted with spreading bars that are secured to the module with half grommet connectors. The bars are generally in the form of angle irons submerged just

below ground surface, extending outwardly on each side of the module. These spreading bars may be used in conjunction with other foundation structures if necessary.

For smaller building structure complexes the gap between the modules and ground may enclosed by boarding and filled with polystyrene. This foundation may be of particular use in areas liable to flooding and also provides for an aesthetic finish. Whilst polystyrene is appropriate for light weight and quick response applications other forms of mineral in-fill may be used for different applications. The type of in-fill and the pressure of this fill is selected accordingly.

The advantage of such a foundation system is that it can be positioned directly on to most ground surfaces without the need for the ground surface to be completely flat or level; or for grass, or similar vegetation, to be removed.

The construction of such a foundation is effected in the following stages:

1. The first stage is necessary in applications where high wind conditions are possible.

Spreading bars are positioned just below the ground surface, and are adequately secured with ground screws or sinkers, etc., vertical grommet fastenings (extended in length) are screwed to the spreading bars at intervals corresponding to the bottom wall connection points.

2. A series of sausage shaped flotation bags (each bag extending as long as the width of the module, and approximately of a third of a meter in diameter, and being divided into separate internal chambers) are laid out across the site so that each module will be supported by at least two flotation bags.

Plastic hessian type sackings are laid between the flotation bags such that when expanded they are sufficiently large to fill the gap between two flotation bags.

3. Ground floor modules are then assembled in their designated formation, over the bags, and are temporarily supported on blocks, sufficient to allow the horizontal grommet fastenings between modules to be loosely engaged, and the extended vertical grommets to be positioned in the leg housing.

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4. The floatation bags are then inflated (using an air pump equipped with a multiple outlet manifold and individual pressure gauges) sufficiently to lift the loose assembly gradually off the ground. Approximate levelling is achieved through adjusting the pressures in the appropriate chambers of the appropriate floatation bags.

Working from one end of the assembly to the other, the horizontal grommets are tightened into position, until the total assembly is secured into horizontal alignment.

The floating assembly can then be finally levelled, and raised or lowered to the desired height.

5. The plastic hessian type sackings, between the floatation bags, are then filled with expanding polystyrene foam, sufficient to fill cavities between the floatation bags, while temporary barriers prevent expansion outwards from the sides of the assembly. The expanding foam is applied in equal pressure in each sack (to a pressure less than that in the floatation bags).

6. After the foam has consolidated, the pressure in the floatation bags is then released and the modular assembly settles on to the polystyrene foundation

The floatation bags are deflated and pulled clear; after which the hollows that are left are filled with expanding polystyrene foam.

7. The vertical grommet bolts, securing the modules to the spreader bars, are tightened into position.

The upper stories of the building can then be assembled.

Finally, when the building is complete, the vertical grommets are re-tightened.

The advantage of this foundation system, over conventional footings, is seen in the difference in the speed and the cost construction. In addition the system, provides for improved insulation and, in view of the filling of the space under the modules, improved aesthetic value and security.

Figure 5 shows part of a corridor module 2 connected to a transversely disposed cabin module 1. The corridor 2 is represented partially cut-away so as to expose service supplies that are carried to each cabin module 1. As mentioned earlier,

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the structure of the corridor 2 is the same as that described in relation to the cabin modules 1. In the ceiling cavity 11 there is an air conditioning plant 40 including conduits as shown at 41 and an electrical supply installation 42 and corresponding wiring 43. A domestic water supply and waste disposal system is carried in the floor cavity 10 as indicated at 44. The corridor modules 2 define walkways that extend across adjacent corridor modules 2 or between corridor 2 and cabin modules 1. Gaps between connected modules are bridged around the walkway area by flexible bellows-type walkway couplings 45.

An example of a two storey modular building structure is shown in Figure 6. The structure comprises two vertically stacked central corridor modules 2, each storey flanked by six cabin modules 1 (three on each side). The modules are interconnected horizontally by the fixing arrangements shown in Figure 2 and vertically by the half grommet fixings of Figure 4a.

In addition, horizontal grommet fixings extend between the edges of the open ends 7 of each module and the side wall of the corridor module 2.

A fully constructed and furnished corridor module is shown in figure 7 with the end shown open to expose the ceiling and floor cavities 10, 11.

An example of a waste disposal system for a building structure of the present invention is shown in figure 8. The system is shown in relation to a corridor comprising three axially joined corridor modules 2 and six cabin modules 1 connected on each side of the corridor 2. A service module 110 containing a suction pump and tank 111 is connected to an end of the corridor 2. Each corridor module 2 has a holding tank 112 in its floor cavity. Each tank 112 has flexible conduits 113 that are connected to a lavatory and wash area 114 of each cabin module 1 and adjacent holding tanks 112 are interconnected by a suction waste pipe 115. The figure also shows the flexible bellows coupling 95 between each corridor module 3 and between each cabin 1 and corridor module 2.

In figure 9, there is shown an exemplary air conditioning system depicted in relation to part of a building structure comprising a central corridor constructed from three axially connected corridor modules 2 and six cabin modules 1, three on each

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side of the corridor 2. At one end of the corridor 2 there is a service module 120 containing a central plant 121 that feeds a heat exchanger 122 in the immediately adjacent corridor module 2. Further heat exchangers 122 are located in each corridor module 2, each heat exchanger 122 being connected to that of the adjacent corridor module 2 and to further heat exchangers 123 situated in each adjacent cabin module 2. An exhaust heat pump 124, connected to the corridor heat exchanger 122, is located outside each corridor module 2. Besides the central air conditioning plant the service module 121 may also contain central alarm and security control systems, service repair and spare equipment, telephone transmission and reception equipment, television reception apparatus, a fresh water distribution manifold, and, in the case of remotely located building structures, electrical generators.

Using corridors of this type it is possible to provide accommodation for short term applications without the need to provide pathways, foundations or to conduct preliminary ground excavation for drains and service supply lines. The investment generally made in creating such facilities are therefore not lost when relocating the building structure. The arrangement also enables building complexes to be sited on sloping or undulating sites without the need for gravity waste disposal. Any noisy equipment is conveniently located in the corridors leaving the cabin modules free of noise, vibration and clutter. The air conditioning also provides protection from outside interference (which is particularly desirable in noisy, dusty environments) as well as reducing condensation.

The standard cabin or corridor modules may be adapted as necessary depending on how they are to be used. For example, the corridor rooves may be made in a double-glassed construction to provide a conservatory. Ancillary structures such as, for example, fire escapes, balconies, canopies and exterior walkways may be connected to the modules by the grommet fixing arrangements described above.

The modular nature of the corridor and cabin modules means that many different building layouts are possible. Examples are shown in figures 10 and 11. The former shows a layout an office block having a first corridor 130 with three office cabin modules 131 on one side and four cabin modules 132 on the other side

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designated for three smaller offices and a pantry. One end of the first corridor module 130 meets a transversely extending second corridor module 133 which is connected to four cabin modules 134 that are furnished as toilets, a reception area, and a service module with store.

In figure 11 there is shown an example layout for a factory with offices. A central corridor 140 comprising two modules interconnects a demonstration and show room 141 comprising two side-by-side cabin modules at one end and a workshop area 142 comprising five side-by-side cabin modules at the other end of the corridor 140. Cabin modules 143 of various sizes connect to the corridor on each side and are furnished as offices, lavatories, a service modules and a pantry. The workshop area 142 is connected to three cabin modules defining a delivery area 144.

Broadly speaking the on-site procedure for constructing a building of this type is as follows:

- a) the service module is delivered to the site and placed in the correct location;
- b) the foundations are laid down with access roads, car parking, boundary fences etc.;
- c) the cabin modules and corridor modules are delivered and secured to the foundations and to each other; and
- d) the mains service supplies are routed from the service module along the corridor floor and ceiling cavities through to the cabin modules and the building is tested for occupation.

The building structures of the present invention differ from previous prefabricated buildings in that they are manufactured in their entirety in modular format together with completed interiors. The buildings are comparatively lightweight, do not have an overall superstructure and require only limited foundations. In view of the modular structure the on-site construction is less complicated and more rapid than conventional buildings. The range of module sizes allows for all buildings to be assembled from factory produced units.

The open-ended tetragonal structure of each module can be fitted with a choice of standard end sections that serve to determine the module identity and purpose e.g a

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compartment module, a corridor module, a container etc. The simple tetragonal cabin module is transformed into a number of mutations by mixing a range of standard modules with a range of standard end sections, as above. These modules can then be combined together into different formations to produce buildings that are all uniquely different.

The integrity of individual modules combined into the cumulative strength of honeycomb building, is further aided by the foam cushioning foundations and the elasticity tolerance in the inter modular fastening. The honeycomb structure in comparison to bricks and mortar, or iron frame construction, is less prone to collapse. If sections of honeycomb buildings are destroyed then the remaining structure can provide sufficient support to maintain the rest of the building in situ.

One of the main advantages is the considerable cost reduction for manufacturing buildings of this kind. A considerable quantity of variable applications can be constructed from comparatively few basic building blocks. The system provides factory finished interiors and internal services which are generally of a higher quality and cheaper to produce than those constructed on-site. The speed and simplicity with which the honeycomb structure building can be erected dramatically reduces the construction time and costs. In addition there is a significant reduction in pre-building costs such as those expended in employing architects, surveyors, site management etc.

The construction of the cabins is suitable for mass production giving both labour and materials cost advantages. The different sizes of module produced by using differing dimensions of the same product means and incorporating different end sections that many different markets can be supplied without creating the need for different manufacturing processes.

Bare cabins (with the floor, ceiling and end sections fitted) can be delivered to special outfitters where they are furnished before being transported to the construction site.

Transportation of the modules is simplified as they are lightweight and strong enabling them to be placed and moved on a lightweight trailer rather than a heavy

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duty vehicle. The structure of the modules is such that they can be transported on their sides if necessary. The modules are also suitable for air transport to inaccessible locations or in military applications or circumstances where a quick response is required (e.g. emergencies such as natural disasters).

Once built, the building structure can later be modified, expanded or reconfigured to suit changing requirements relatively simply. In addition, the building structure can be relocated in whole or in part with ease.

Since the component modules are of standard design, the building structure lends itself well to simple computer modelling and virtual reality systems that enable layout planning. The simplicity would also enable the end user of the building to participate in the design of the building.

The modular nature of the building enables it to be enlarged or reduced in size as appropriate. This may have advantage for both the residential and commercial market. For example, first time residential buyers will be able to start with a small one bedroom house, expand the size of the building over time by adding extra modules as the family grows and reduce the size of the building by removing modules as the family size diminishes. The style of the house can be constructed to suit the owner's preferences. Similarly, in the commercial realm the size of the building can be varied throughout its life to reflect the growth or diminishing size of the business.

Similarly, disused modular buildings can be dismantled and removed so that ugly, dilapidated or vandalised buildings can be quickly removed. A minimum disturbance to land structure means that land can be returned to green site conditions after the buildings have been removed

Valuing property for sale or financing purposes is simplified in that the value of the property is no longer restricted by its location and design and can be easily assessed by the aggregate value of its component parts while the site is valued separately in terms of size and location.

The present invention provides for improved durability in prefabricated buildings of about 40 years with a higher standard of interiors and internal services as compared to the 15 years for existing structures.

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CLAIMS

1. A modular building structure comprising a service module defining a plurality of connection nodes for connection to separate building modules, the service module containing apparatus for the supply and distribution of at least one mains service to the building modules, each building module being free-standing, pre-fitted for its intended use and connected to one of said connection nodes and to said supply of at least one mains service, wherein the service module is in the form of a corridor walkway linking the building modules.
2. A modular building structure according to claim 1, wherein each module is an open-ended box configuration.
3. A modular building structure according to claims 1 or 2, wherein the service module has floor and ceiling cavities in which the mains service supplies are routed.
4. A modular building structure according to any one of claims 1 to 3, wherein one building module is a dedicated plant room that feeds the mains supply service to the service module.
5. A modular building structure according to any preceding claim, wherein the service module is sectional so that it can be extended or shortened to provide more or less connection nodes as required.
6. A modular building structure according to any preceding claim wherein there is provided a plurality of service modules, some modules being disposed in a direction transverse to others.

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7. A modular building structure according to claim 6, wherein the mains service is for waste disposal and each service module is provided with a holding tank that is connected to a lavatory or wash area of an adjacent building module.
8. A modular building structure according to claim 7, wherein holding tanks of adjacent service modules are connected by a suction waste pipe.
9. A modular building structure according to any preceding claim, wherein the mains service supply is air conditioning and each service module is fitted with a heat exchanger and has an external pump for evacuation of warm air.
10. A modular building structure according to claim 9, wherein each building module also has its own heat exchanger that is connected to the pump and heat exchanger of an adjacent service module.
11. A modular building structure according to any preceding claim, wherein each adjoining pair of building modules or service modules has apparatus for connecting adjacent modules, the apparatus comprising a housing defining apertures that extend into the structure of each module and a flexible resilient insert that is snugly received in each aperture and bridges the two modules, the insert being supported on a fixing element that is secured to each of the modules.
12. A modular building structure according to any preceding claim, comprising multiple storeys, vertically adjacent modules being connected by a connecting member comprising a resilient flexible insert attached to one module and received in an aperture of the vertically adjacent module.
13. A modular building structure according to any preceding claim, wherein the modules are connected to a foundation of foamed mineral in-fill.

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14. A method for constructing a modular building structure, the method comprising the steps of: preparing a site on which the building structure is to be located; installing a service module on the prepared site, the service module defining a plurality of connection nodes for connection to separate building modules; installing at least one mains supply service to the service module; connecting at least one pre-constructed building module to a connection node and connecting the building module to the mains supply service of the service module; and furnishing the service module such that it is in the form of a corridor walkway linking the building modules.

15. A method according to claim 14, comprising further steps of filling a clearance between the module and ground with a foundation of foamed mineral in-fill.

16. Apparatus for connecting adjacent building modules, the apparatus comprising a housing defining an aperture that extends into the structure of at least one building module and a flexible resilient insert attached to adjacent module, the insert being received in the aperture and supported on a fixing element that is secured to said adjacent building module.

17. Apparatus according to claim 16, wherein each horizontally adjacent module has an aperture, the flexible resilient insert is received in each aperture and bridges the two building modules.

18. Apparatus according to claim 16, wherein the modules are vertically adjacent, one of the modules having projecting therefrom said resilient flexible insert and the other having said aperture.

19. Apparatus according to claims 17 or 18, wherein the housing further comprises an access chamber that is open to the inside of the building module so as to facilitate insertion of the fixing element and flexible insert.

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20. Apparatus according to claim any one of claims 16 to 19, wherein the apparatus for connecting adjacent building modules is disposed in a floor or ceiling cavity of the building module.

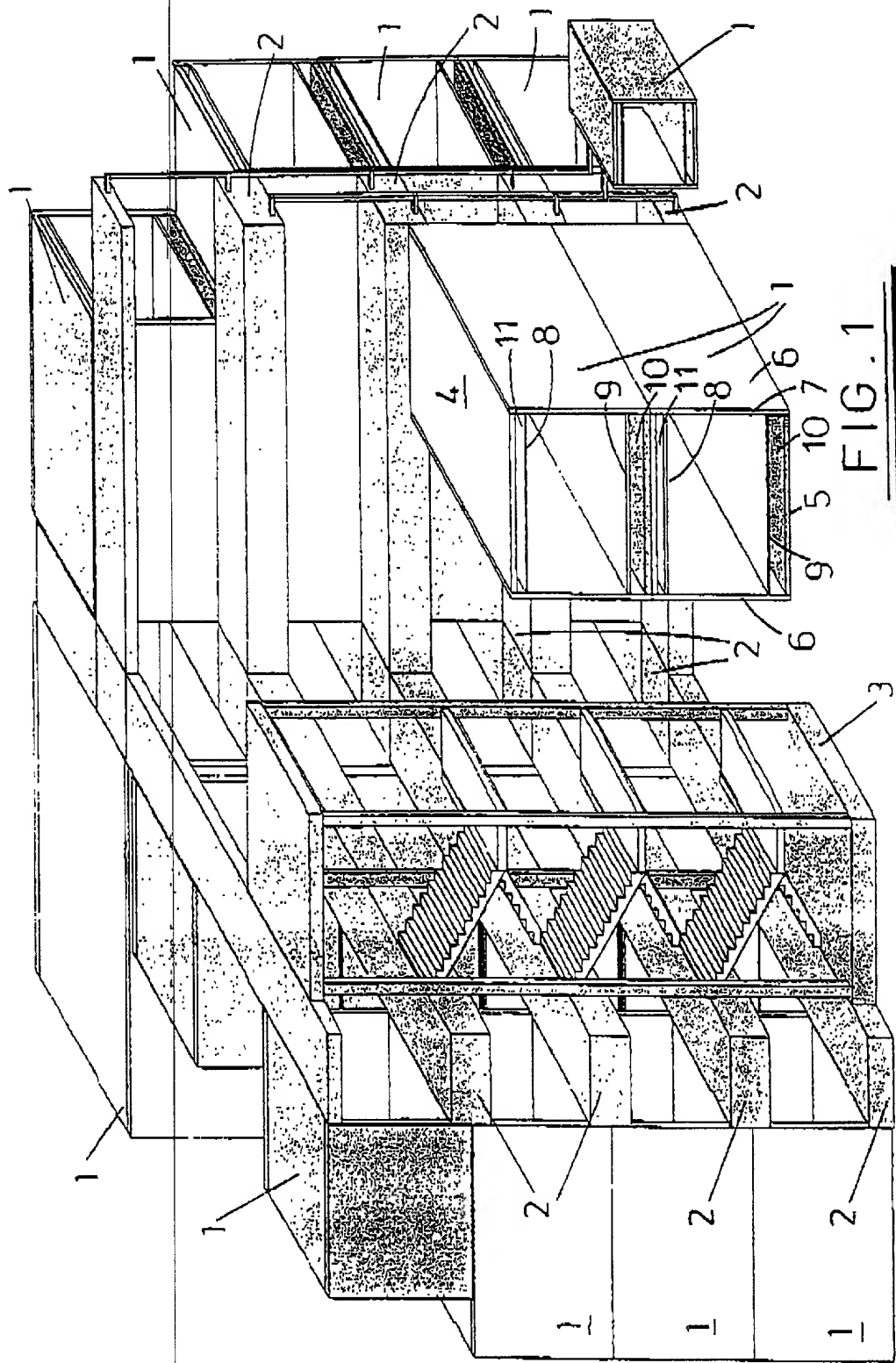
21. Apparatus according to any one of claims 16 to 20, wherein the insert is a grommet.

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FIG. 3

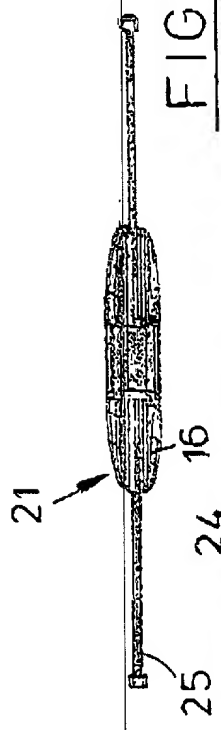


FIG. 3



FIG. 4

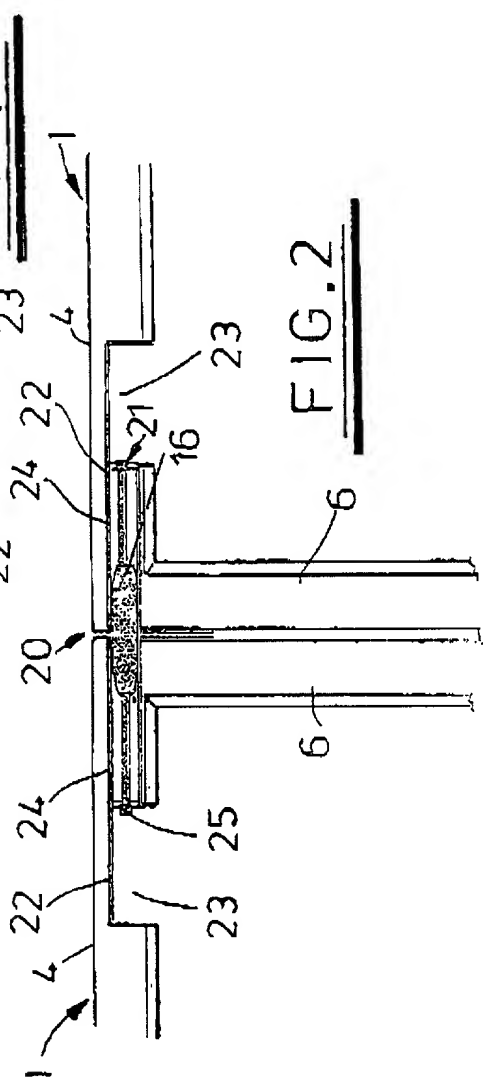


FIG. 2

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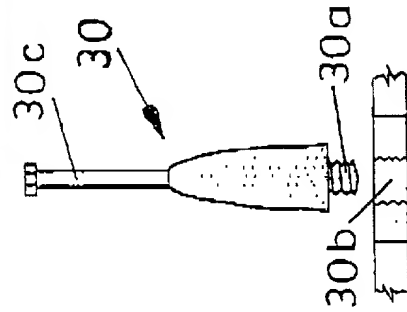


FIG. 4a

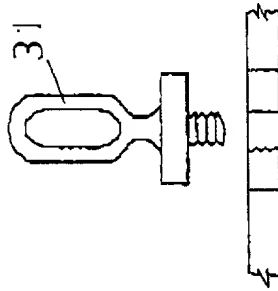


FIG. 4b

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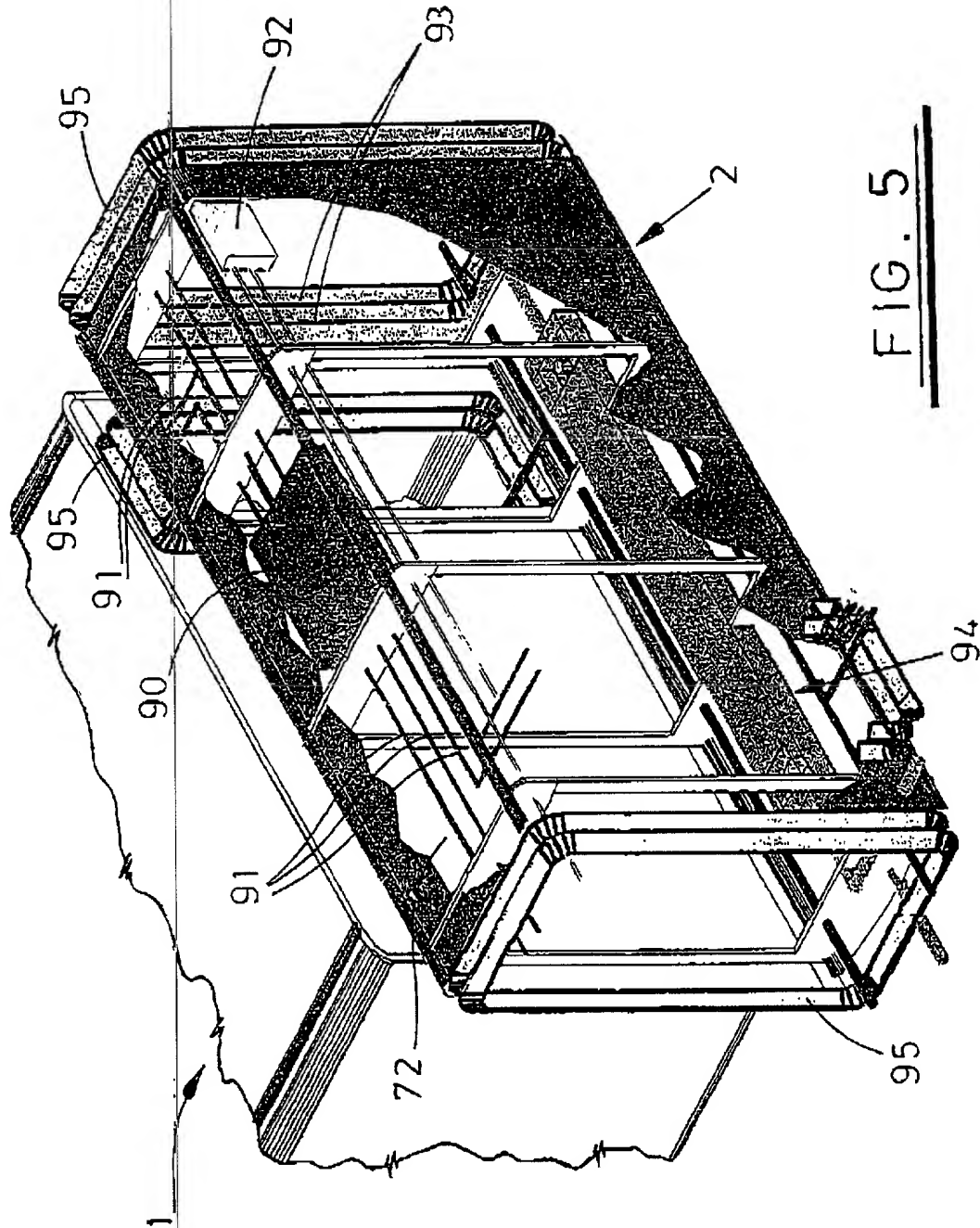
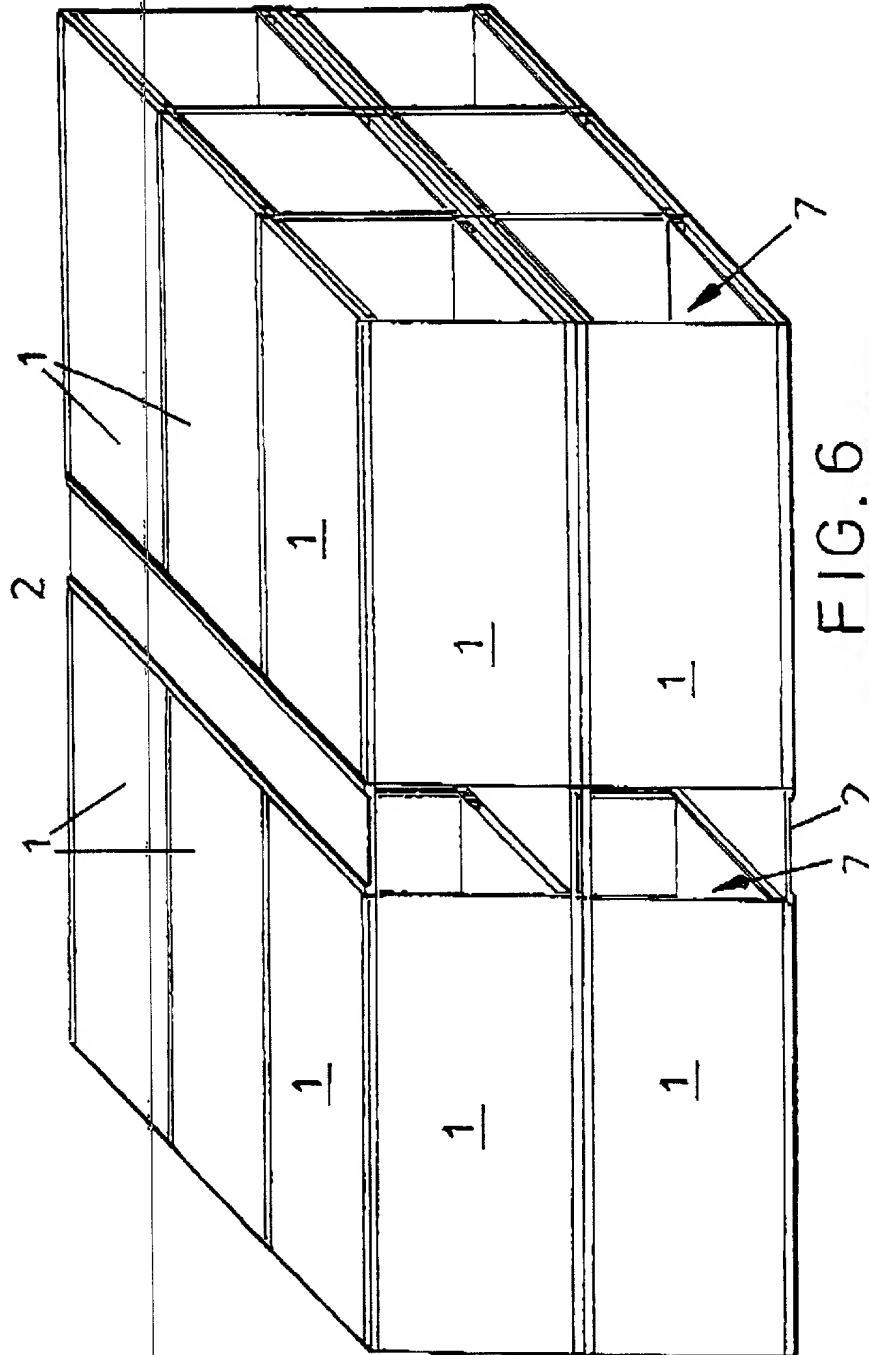


FIG. 5

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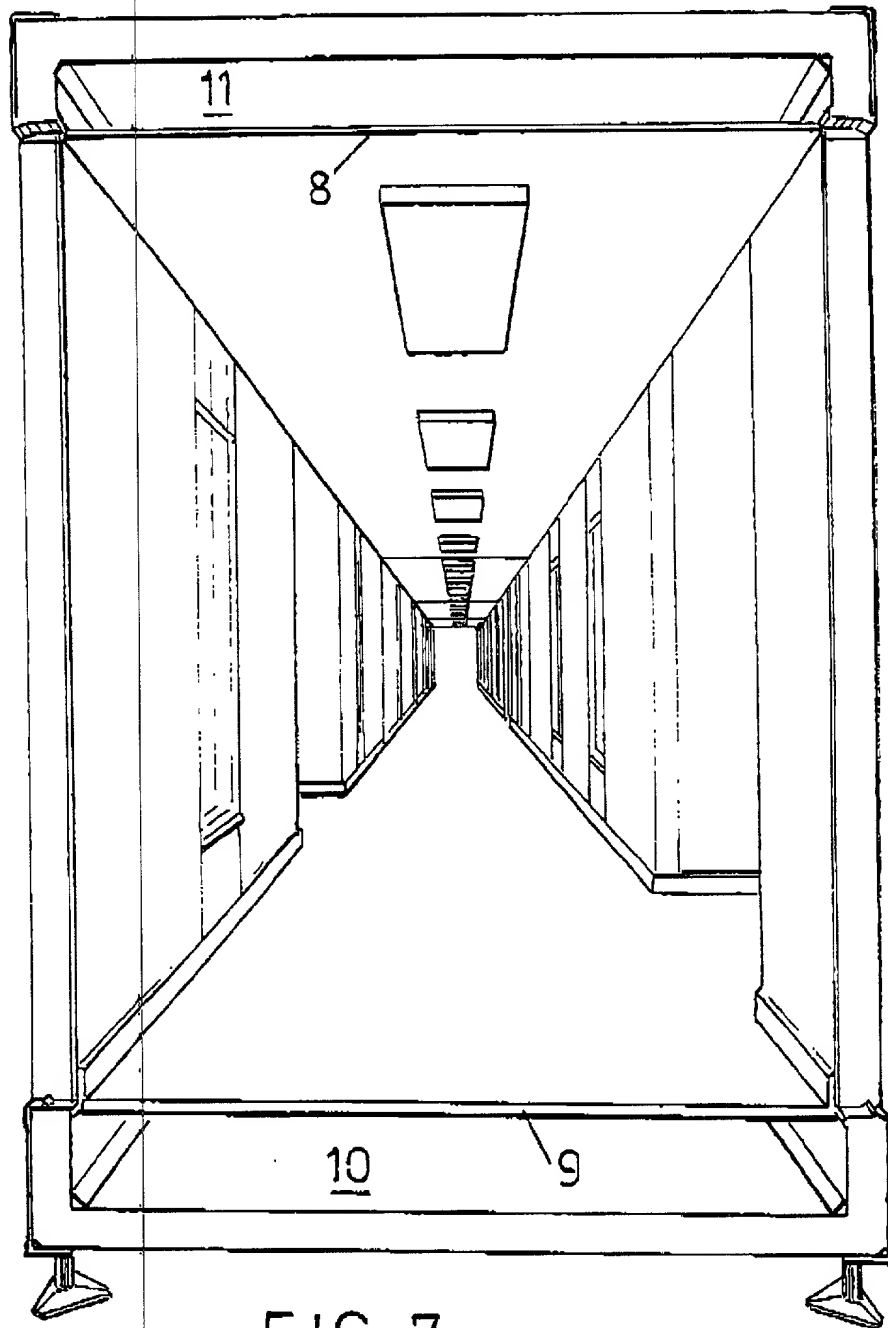
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6-9FIG. 7

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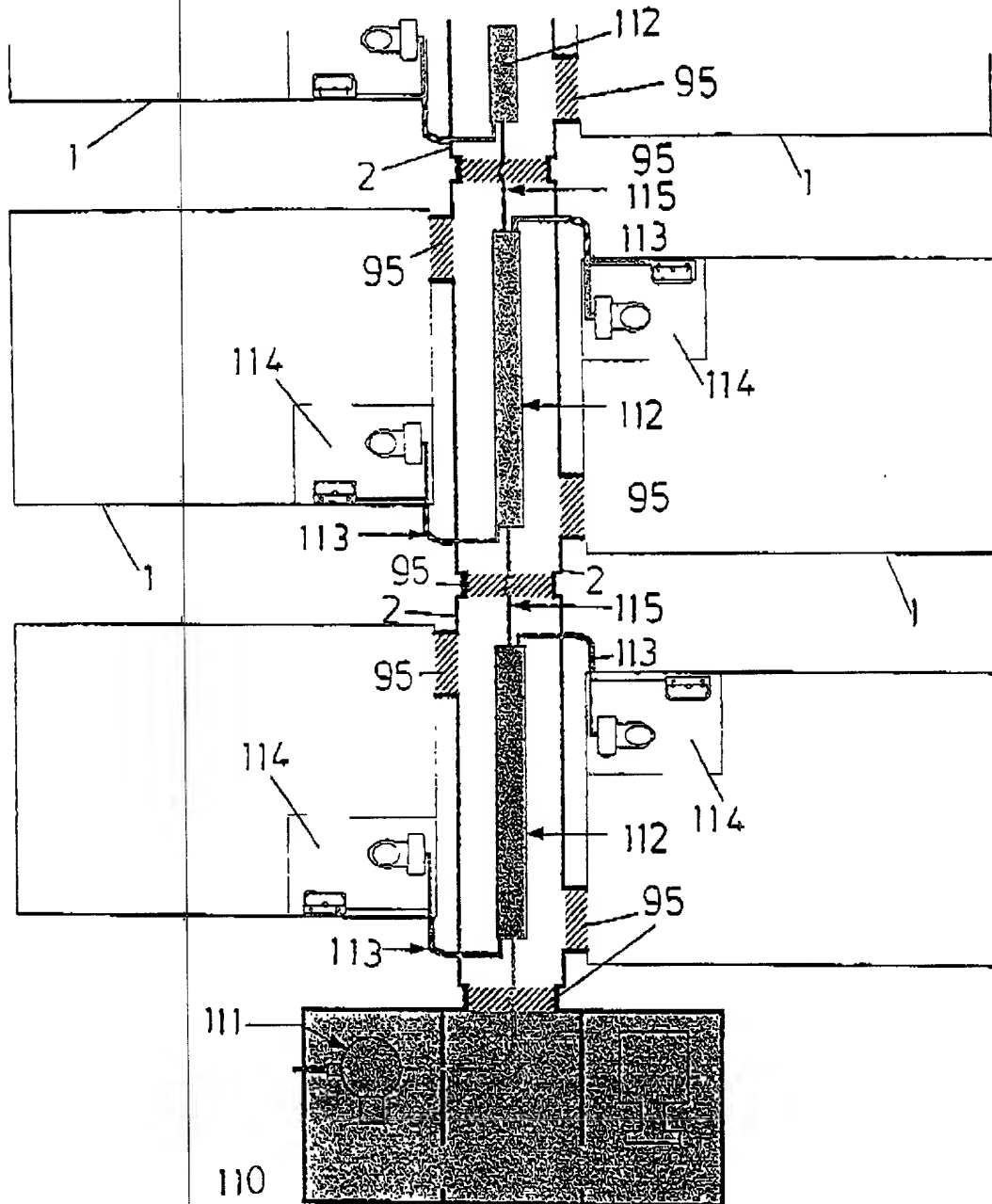
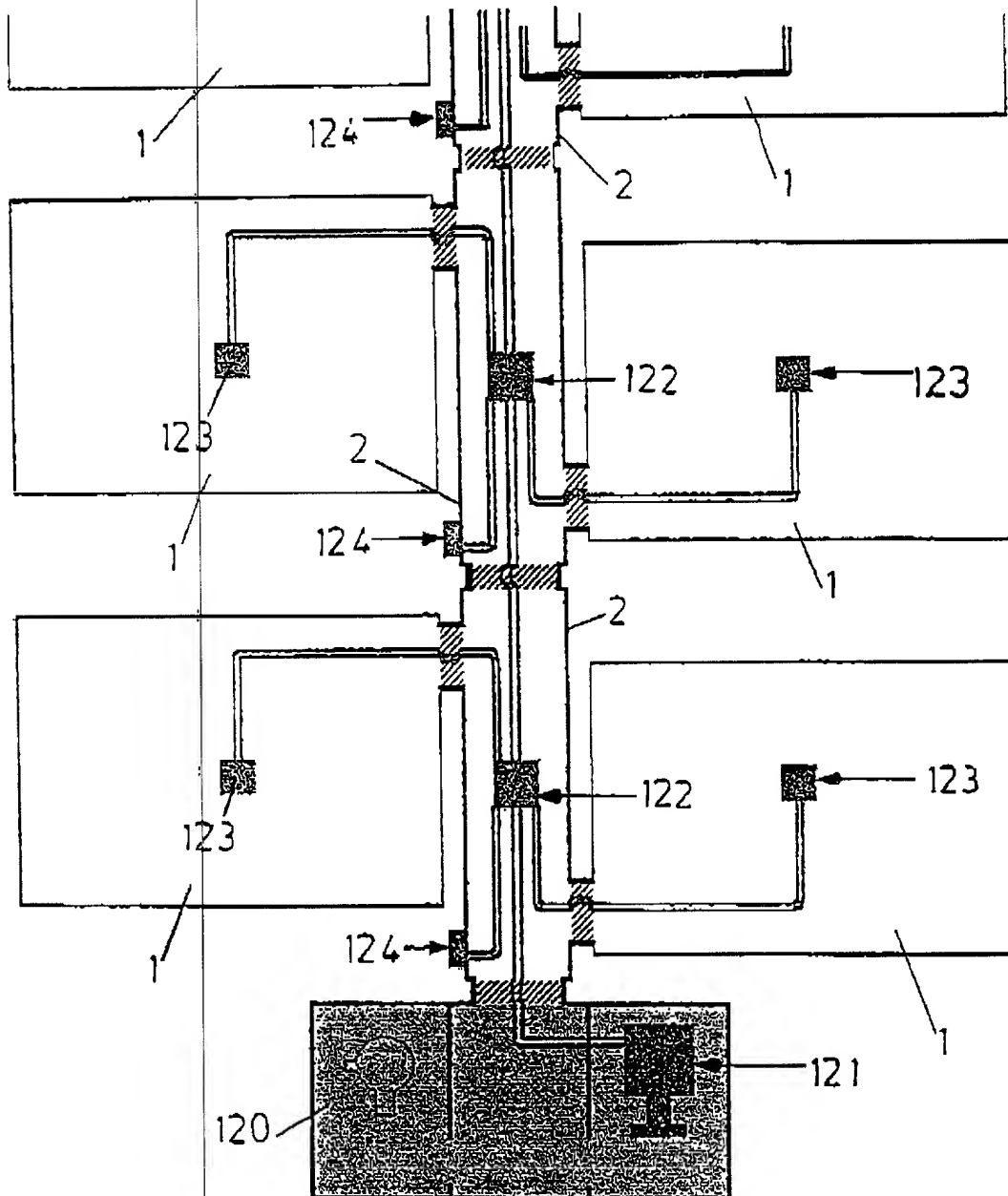


FIG. 8

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FIG. 8

FIG. 9

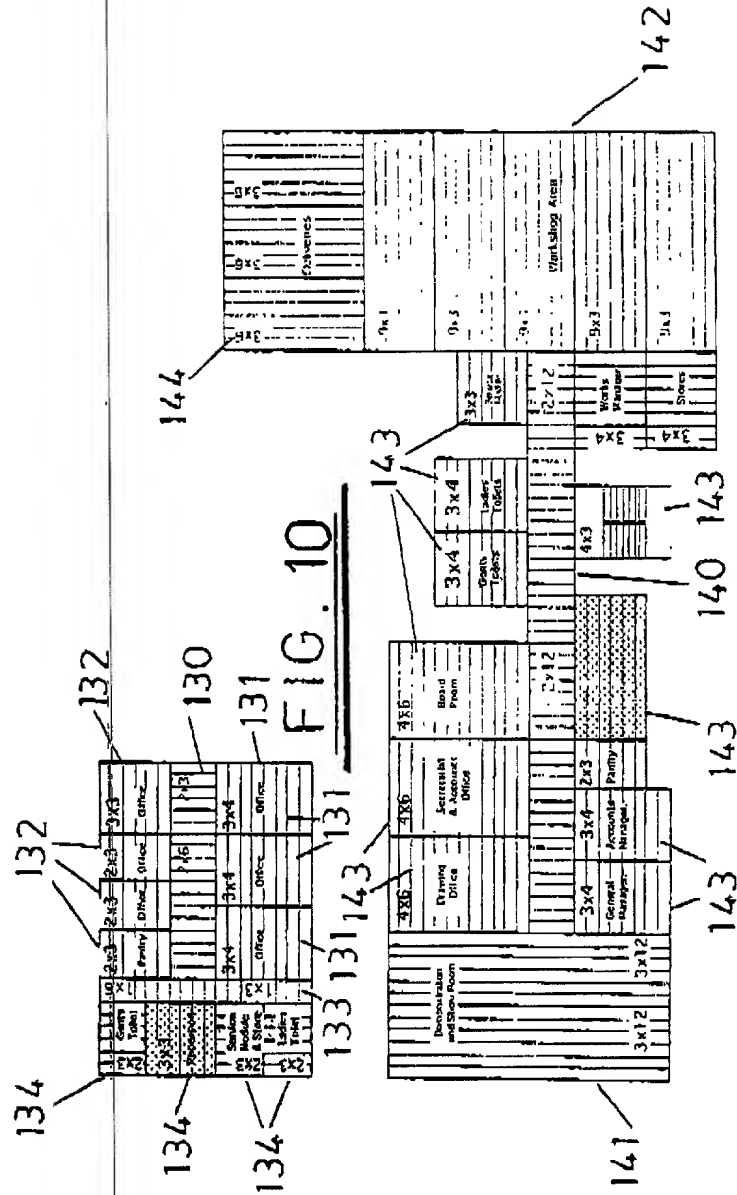
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DECLARATION AND POWER OF ATTORNEY FOR UTILITY OR DESIGN PATENT APPLICATION

Attorney Docket
Number

7399-2

First Named
Inventor

Peter William De La Marche

COMPLETE IF KNOWN

Application No.

Filing Date

Group Art Unit

Examiner's Name

☐ Declaration submitted with
Initial Filing

☐ Declaration
Submitted after
Initial Filing
(surcharge (37 CFR
1.16(e)) required)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

MODULAR BUILDINGS

the specification of which
(check one)

☐ is attached hereto.

☒ Was filed on July 5, 1999 as United States Application No. or
PCT International Application No. GB99/02141

☐ And was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YY)	Priority Not Claimed	Certified Copy Attached?	
				Yes	No
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9814332.4	GB	07/03/98		<input type="checkbox"/>	<input checked="" type="checkbox"/>

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	<input type="checkbox"/> Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

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DECLARATION

REGISTERED PRACTITIONER INFORMATION (Supplemental Sheet)

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William F. Bahret	31,087		
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Kurt N. Jones	37,996		
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J. Andrew Lowes	40,706		
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Jason J. Schwartz	43,910		
Arthur J. Usher IV	41,359		
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Scott J. Stevens	29,446		
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Rev. 3/19/99

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I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

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☐ Additional US or PCT International application numbers are listed on a supplement priority data sheet PTO/SB/02B attached hereto.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor:			
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Inventor's Signature:		Date of Signature:	X 18 January 2001
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